Obituary

# David Shoenberg (1911–2004)

David Shoenberg was the last survivor of the distinguished group of scientists who established low-temperature physics as a flourishing discipline in Britain before the Second World War. His father was the electronic engineer Isaac (later Sir Isaac) Shoenberg, who came to England from Russia with his family in 1914, and who led the team at EMI that developed television for the BBC in the 1930s.

At Cambridge in 1932, David Shoenberg became one of the very few research students taken on by Pyotr Kapitza, the brilliant Russian engineer–physicist who was then developing techniques for producing high magnetic fields. Kapitza set him on measuring the magnetostrictive effect — the minute length changes produced by a magnetic field — in bismuth. This was a project to test the ablest experimentalist, but one that Shoenberg completed successfully three years later. By that time he was on his own: in 1934, Kapitza had not been allowed to return from Russia after his annual summer holiday there. Shoenberg spent the next few years working mainly on superconductivity and writing a book that long remained the best introduction to the topic.

In 1937 Kapitza invited him to Moscow to work for a year in his newly built laboratory. There Shoenberg began to study in earnest the phenomenon that was to occupy him, very fruitfully, for the next 50 years. The de Haas–van Alphen (dHvA) effect is an oscillatory variation of a metal's magnetic susceptibility with magnetic-field strength at low temperatures, first observed in bismuth in 1930. Shoenberg and M. Z. Uddin had published a brief study of it in 1936, but now Shoenberg's measurements were far more sensitive and precise. It remained to interpret these strange oscillations.

Rudolf Peierls had already produced a rather cumbersome theoretical explanation, but fortunately the brilliant Russian theoretician Lev Landau was also working in Kapitza's laboratory, and he at once came up with a much more powerful formulation, making the analysis of the experimental results far easier. In 1938, however, Landau was declared an 'enemy of the people', and it became impossible to cite his work. All references to his theory were deleted when Shoenberg's work was published in a Russian journal, but Shoenberg was able to include a full account of it, correctly attributed, in the Royal Society version of his paper.



Pioneer in 'fermiology' — the study of electrons in metals

Since the advent of quantum mechanics in the 1920s, the field of solid-state physics had developed rapidly, and one of the central problems was to understand the properties of conduction electrons in metals. Considerable theoretical progress had been made, marked by the appearance of Hans Bethe's monumental article in the *Handbuch der Physik* in 1933, but so far little light had been shed on their behaviour experimentally.

Using Landau's theory (as generalized in 1951 by Lars Onsager and Ilya Lifshitz), Shoenberg made the dHvA effect into a powerful tool for understanding the behaviour of conduction electrons in metals. The electronic properties of metals are largely determined by the nature of the 'Fermi surface', a surface defined in momentum space that separates the lower-energy, filled electron states from the empty, higher-energy states. The science of 'fermiology' — the determination of the shape of this surface, and the velocities and collision rates of the electrons on it — has occupied many solid-state physicists profitably for many years, using the techniques developed by Shoenberg.

Bismuth was the first metal (or semi-metal) in which the oscillatory phenomenon had been observed, because it has a low density of conduction electrons (so its Fermi surface is unusually small), and the theory showed that this made the effect easier to observe in reasonably low magnetic fields. Until 1947 it remained the only material in which the dHvA effect had been observed, but in the next few years it was seen and studied in a variety of other metals, by Shoenberg and others.

It proved remarkably difficult to observe the effect, however, in the noble metals copper, silver and gold, which required much higher magnetic fields. Shoenberg eventually solved the problem, elegantly and ingeniously, by discharging a bank of capacitors through a magnet coil to produce a field that rose rapidly to a peak and then fell again to zero. This field produced a time-dependent oscillatory magnetization in the sample, detected by a search coil wound around it. In 1958 he at last succeeded in detecting the dHvA effect in a copper whisker — although, as he wrote later in his definitive book on magnetic oscillations, "the breakthrough came by a combination of luck and slightly faulty reasoning". Such disarming honesty was characteristic of the man.

The pulsed-field apparatus was not easy to use. It was usually operated by Shoenberg's assistant E. Laurmann, a dour Estonian who had worked with Kapitza. On one occasion, when Laurmann went off for lunch while results were coming fast, Shoenberg tried his hand at operating the apparatus himself — the resultant bang when he accidentally short-circuited the capacitor bank left him permanently a little hard of hearing.

Since those days, the advent of superconducting magnets has made it much easier to attain the high fields needed in dHvA studies. The dHvA effect has been used extensively to study a variety of metals and many complex phenomena, including magnetic breakdown and the 'B–H effect', both discovered by Shoenberg and his students. Later studies include the 'Fermi-liquid effects' arising from electron–electron interactions, heavy-fermion effects, in which electrons seem to have a far heavier effective mass than simple theory would predict, and the 'mixed state' of superconductors. In all of these areas the dHvA effect has proved a powerful tool.

Until late in life, Shoenberg loved to travel abroad — to Russia, India, the United States and elsewhere — to meet friends and former students. Friendly, amiable and completely straightforward, an expert at asking the seemingly innocent but important question, David had a host of friends in many countries, who will miss him greatly.

**R. G. Chambers**

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